

gold ornaments which were found there. Most people think that these tombs, whosever they were, date from at least 1000 B.C. On the other hand, some very high authorities regard the monuments as the tombs of northern invaders who came into Greece 500-600 A.D. Here then we have a range of some 1500 years for the date of the tombs, and no dates between these two are possible. I am sure I do not pretend to decide between them, or even to have an opinion on the subject; but I cannot help saying that in one respect the astronomers are better off than the historians. The historians cannot even agree whether Schliemann's gold ornaments are B.C. or A.D. Astronomers are, at all events, certain that the date of the moon's birth was before the present era.

At the critical epoch to which our retrospect extends, the length of the day was only a very few hours. I cannot tell you exactly how many hours. It seems, however, to have been more than two and less than four. If we call it three hours we shall not be far from the truth. Perhaps you may think that if we looked back to a still earlier epoch, the day would become still less and finally disappear altogether! This is however not the case. The day can never have been much less than three hours in the present order of things. Everybody knows that the earth is not a sphere, but that there is a protuberance at the equator, so that, as our school books tell us, the earth is shaped like an orange. It is well known that this protuberance is due to the rotation of the earth on its axis, by which the equatorial parts bulge out by centrifugal force. The quicker the earth rotates the greater is the protuberance. If, however, the rate of rotation exceeds a certain limit the equatorial portions of the earth could no longer cling together. The attraction which unites them would be overcome by centrifugal force, and a general break up would occur. It can be shown that the rotation of the earth when on the point of rupture corresponds to a length of the day somewhere about the critical value of three hours, which we have already adopted. It is therefore impossible for us to suppose a day much shorter than three hours. What occurred prior to this I do not here discuss.

Let us leave the earth for a few minutes, and examine the past history of the moon. We have seen the moon revolves around the earth in an ever-widening orbit, and consequently the moon must in ancient times have been nearer the earth than it is now. No doubt the change is slow. There is not much difference between the orbit of the moon a thousand years ago and the orbit in which the moon is now moving.

But when we rise to millions of years the difference becomes very appreciable. Thirty or forty millions of years ago the moon was much closer to the earth than it is at present; very possibly the moon was then only half its present distance. We must however look still earlier, to a certain epoch not less than fifty millions of years ago. At that epoch the moon must have been so close to the earth that the two bodies were almost touching. I dare say this striking result will come upon many with surprise when they hear it for the first time. It was, I know, with great surprise that I myself read of it not many months ago. But the evidence is unimpeachable, and it is indeed wonderful to see how such information has been gained by merely looking at the ripples of the tide.

Everybody knows that the moon revolves now around the earth in a period of twenty-seven days. The period depends upon the distance between the earth and the moon. The time and the distance are connected together by one of Kepler's celebrated laws, so that, as the distance shortens, so must the time of revolution shorten. In earlier times the month must have been shorter than our present month. Some millions of years ago the moon completed its journey in a week instead of taking twenty-eight days as at present. Looking back earlier still, we find the month has dwindled down to a day, then down to a few hours, until

at that wondrous epoch when the moon was almost touching the earth, the moon spun round the earth once every three hours.

It would require the combined powers of a poet and a mathematician to pourtray the scene with becoming dignity. I have only promised to give you that glimpse along the Corridors of Time which I have myself been able to obtain. The scene is laid in the abyss of space; the time is more than 50,000,000 years ago; the *dramatis personæ* are the earth and the moon.

In those ancient times I see our earth to be a noble globe, as it is at present. Yet it is not partly covered with oceans and partly clothed with verdure. The primæval earth seems rather a fiery and half-molten mass, where no organic life can dwell. Instead of the atmosphere which we now have, I see a dense mass of vapours in which perhaps all the oceans of the earth are suspended as clouds. I see that the sun still rises and sets to give the succession of day and of night, but the day and the night together only amount to three hours instead of twenty-four. Almost touching the chaotic mass of the earth is another much smaller and equally chaotic body. Around the earth I see this small body rapidly rotating. The two revolve together as if they were bound by invisible bands. This smaller body is the moon. Such is the picture which I wish to present to you as a glimpse through the Corridors of Time.

I have hitherto refrained from introducing any merely speculative matters. If we can believe anything of mathematics, anything of dynamics, we must admit that the picture I have attempted to outline is a faithful portrait. The only uncertain elements are the date and the periodic time. I do however now propose to venture on one speculation in which Mr. Darwin has indulged. I propose to offer a suggestion as to how a small body came into this most remarkable position close by the earth, and how its motion was produced.

We have hitherto been guided by the unerring light of dynamics, but at this momentous epoch dynamics deserts us, and we have only probability to guide our faltering steps. One hint, however, dynamics does give. It reminds us that a rotation once in three hours is very close to the quickest rotation which the earth could have without falling to pieces. As the earth was thus predisposed to rupture, it is of extreme interest to observe that a cause tending to precipitate such a rupture was then ready to hand. It seems not unlikely that we are indebted to the sun as the occasion by which the moon was fractured off from the earth and assumed the dignity of an independent body. It must be remembered that the sun produces tides in the earth as well as the moon, but the solar tides are so small compared with the lunar tides, that we have hitherto been enabled to neglect them. There could however have been no lunar tides before the moon existed, and consequently in the early ages before the moon was detached the earth was disturbed by the solar tides, and by the solar tides alone.

The primæval earth thus rose and fell under the tidal action of the sun. Probably there were no oceans then on the earth; but tides do not require oceans, or even water, for their operation. The primitive tides were manifested as throbs in the actual body of the earth itself, which was then in a more or less fluid condition. Even at this moment bodily tides are disturbing the solid earth beneath our feet; but these tides are now so small as to be imperceptible when compared with the oceanic tides.

(To be continued.)

SOME "GUESSES AT TRUTH" OF THE EMPEROR KHANG-HI

KHANG-HI or Khang-hsi, one of the greatest of Chinese emperors, and indeed of Asiatic rulers, was born in 1653 and ascended the throne in 1661. For

sixty-one years he ruled his vast dominions with vigour and success. His biographers, the Jesuit missionaries, whom he treated with unusual consideration, represent him as a Chinese Admirable Crichton—man of letters, *savant*, philosopher, politician, philanthropist, and warrior. In his early years he showed the utmost ardour for study, and the love of learning continued with him until his death. When the Jesuits taught European astronomy he did not hesitate to place himself under them as a student. He has left behind him works on most branches of human knowledge, extending over a hundred volumes. The fourth part contains his observations on natural history and physics. It was translated into French by Père Amiot, and partially published at Paris towards the end of the last century in the *Mémoires concernant les Chinois*, and is to be found in the fourth volume of that series. We here extract and summarise a few of the Imperial opinions. To use the words of the translator, "If our scholars find nothing to learn there, they will at least see that there is not so much ignorance amongst foreign nations as is generally believed." We follow the Emperor's language as far as possible.

Earthquakes.—Some years ago, when reading for instruction, as well as to foster my love of truth and reason, I had the curiosity to examine into the causes of earthquakes. One writer says that they come from air confined in the bowels of the earth, seeking to burst its prison and make an aperture for itself. An earthquake hardly ever extends more than ten leagues in area, although its effects may be felt over a hundred leagues. The manner in which a shock is felt on the surface depends on the nature of the ground through which it is transmitted. When the air [within the earth] is exhausted by a great shock there is no danger of another for some time; but a weak shock is almost always the prelude to another. In the dynastic history of Song it is stated that earthquakes are produced by the struggles of the *Yang*¹ against obstacles within the earth; while another work attributes them to the efforts made by the *Yang* and *Yin* to separate from each other. The countries north-west of China are very subject to earthquakes, ten years scarcely ever passing without one. The reason of this is that these districts contain vast sandy tracts where there is little rain, and the air within the earth is therefore keener and more vigorous. Earthquakes, on the other hand, which take place in countries adjoining the sea are less violent, for the earth is humid, and softens the air. People accustomed to the sea assert that there is no wind before an earthquake, and that at such times experienced pilots get as far off from the land as possible. This shows that the shocks are caused wholly by air.

Volcanoes.—An ancient writer states that a certain mountain in Yunnan was called the fire-mountain, because flames came from an opening in it. Some modern critics have accused this historian of lying; but volcanoes do certainly exist. They are mentioned in the records of the Song dynasty, and in other books. In the country of the Mongols flames are thrown up in many places. The fertility of the soil is much increased by these fires, for the people sow their grain near them, and reap a bountiful harvest in a few months.

Form of the Earth.—It seems evident from tradition and records that the North Pole has always remained in the same position. But what is the shape of the earth? Europeans, who are great travellers, say that it is round, and astronomy confirms this. One philosopher says that it is very old, and compares it to the yolk of an egg. How many things there are which we do not understand, but which will be known to future ages! We know the extent of our knowledge from ancient books, and so it will be with posterity from our books.

The Mariner's Compass.—The magnetic needle always declines a little. It cannot point directly to the south. This declination is uncertain, and does not depend always on the country. In the twenty-second year of my reign (1683) it declined three degrees at Peking, but only two and a half at present. The declination may be towards the east in one province, and towards the west in another. One of the Song letters says that this depends on the manner in which the needle is magnetised; but then why should the same needle vary in different years?

¹ *Yang* and *Yin*, the dual powers which, united, Chinese philosophers regard as forming, directing, and modifying all things: the male and female principles.

Moreover, each compass should have its own declination, and there should be some which do not decline at all. Can it be that there is some accidental cause which is peculiar to each country? I believe Europeans say the needle turns towards the north; the ancients say that it is towards the south. Which is right? Neither party says why, and therefore no more is learned from one than from the other. However the ancients are the earliest recorders, and the more I see the more convinced I am that they understood the workings of nature.

Sound and Tones.—Nothing is apparently more simple than the theory of sound; but nothing is really more difficult or complicated. Sound conveys to the mind the developed ideas of others. The pleasure derived from music is half way between that felt at the art and the grosser voluptuousness of the senses. People possess ears without reflecting why, or what services they render and pleasures they procure. For myself, I have always been struck with the manner in which the tone of voice expresses the most varied emotions of the mind. It is not necessary to see the face, or even to hear the words spoken; the tone alone is sufficient to tell how the speaker is moved. It is with the voice as with beauty, the impressions made by it vary according to the person. There are people whose voices go straight to the heart, and are sufficient of themselves to inspire friendship or love. This fact, it is certain, is part of a theory of which we as yet know little. I have read many works on the theory of echoes. The ignorant account for them by fables, and the learned give rules. I think the vibrations of two loud chords struck in unison should serve to explain the reason of echoes heard in valleys and from the walls of buildings.

The simpler the laws of nature and the more sublime, the farther they are from our comprehension; my own thoughts are most frequently those of doubt. I turn away from those who pretend to explain everything and wait for an explanation of the concord of the cords of the *king*¹ with the flute, the different sounds of a hundred instruments, and the numerous voices that find their way into the air, bearing to our ears an indefinable sense of harmony. Awaiting this I say to myself with the ancients, "That which is nearest us is most remote from our comprehension." My ignorance on these matters has never troubled me, because it is no obstacle to that great duty to flee the evil and do that which is good.

Climate.—The effect of climate on the inhabitants of a country as well as on its productions is very great. The men of the south are women compared with those of the north. Vigour of body imparts vigour of mind. When our court was in the south the increase of riches consequent on its sojourn there caused luxury, effeminacy, and a corruption of manners which almost changed the men into women, so enslaved and delicate did they become in this prosperity. Now that it is in the north, they have become firmer, more active, and more regular. Naturalists and astrologers are equally mistaken when they judge of the character, genius, inclinations, and customs of men according to climate and the stars. My Tartars are Tartars, as regards manner of life, as much in the southern provinces as in the north, and people from the south retain their habits when they come to the north. The history of each province exhibits *savants*, literary men, artists, warriors, and monsters alike. Man is man everywhere, and there is often as much difference between the people in one town as between those in provinces distant from each other. Leou-chi has truly said, "No climate tames the tiger, or gives courage to the rabbit."

Winds.—The proverb says that the wind which blows is the same a hundred leagues away, but the rain which falls is not the same ten leagues off. Why should this be? One can only reason on facts after knowing them, and I know that the statement respecting the wind is not always correct, for there have been different winds at the same time in the provinces of Pechili and Shantung, which adjoin each other. It seems to me that winds depend on the nature of a country. One writer says that they depend on the motions of the stars, and that therefore they never cease, although at one time they may be more violent than at another, according as they are more or less impelled towards the earth. Moreover, the change in the direction of the wind comes from the same cause. The air being confined between the earth and the higher spheres, escapes where it can; and possibly the difference between a high and a low wind may be explained in this way. Another ancient writer says that the quarter from which the winds come depends on the season, and that they pass directly from one cardinal point to another. All

¹ *King*, a sort of dulcimer made of glass or stone.

other winds are temporary and accidental. I have paid particular attention to this matter, and I find the usual wind in Peking is from the south-west, and that other winds do not continue for any length of time. From the *Y-king* it appears that was the same in the most ancient times. It is a fact, attested by the daily record of our observatory here, that the wind does not remain long in any of the four cardinal points, as asserted by the writer above mentioned. Whatever be the causes of the different directions of the wind, it is certain that there are local and temporary, as well as general and universal ones. These can only be discovered by a multitude of observations. Again, why is it that when the wind blows, ice melts first at the water's edge, unless it be that the wind has penetrated the water? A more singular fact still is that there are some winds which are only felt in deep water. The history of the Yuen dynasty affirms that people bathing have become icy cold from a wind of which they have become suddenly sensible.

Thermal Springs.—Nothing is truer than that mineral waters are very efficacious in curing several maladies. They are better for those past forty years of age than for younger persons. Hot baths enfeeble and exhaust the latter, because, the blood still possessing all its force, they cause fermentation and perspiration, which disorder and injure the constitution. At a more advanced age, on the other hand, they revivify the blood and clear the bones, nerves, and tissues of the body from the impurities which years bring in their train. Baths should not be taken for some time after eating, and one should be careful of exposure to the air after them. I mention this because everything affecting the health of mankind interests me. It is clear that the heat, smell, taste, and medicinal virtues of thermal springs are the effects of a mixture of foreign substances in the water. But what are these substances? In what quantity and proportion are they present? This has not been sufficiently examined. Whenever I meet a mineral spring on my journey I examine it by means of an alembic, and by the alum, sulphur, or metal found there I know its properties. In this respect we must not follow the ancients. They decided superficially by the taste, smell, or colour. I wish these waters were studied better, as then it would be known what diseases they were best suited to cure.

We have not space to give any more of the Emperor's observations. Those translated above are sufficient to show his love of knowledge, and his desire to benefit his subjects by utilising the results of research. Some of his remarks are almost epigrammatic, and with a few of them we will bring this article to a close.

"Lying is the first resource of ignorance; but what shall we do when we do not know the truth? Be silent."

"I love to admire the manner in which nature confounds our ideas of the greatness of human industry, and baffles all the resources of our penetration. How difficult it is to admire worthily! Is not a small insect, a blade of grass, more worthy of our admiration than any production of human hands?"

"We spoil children by our puerile cares for their health. We have, alas! too many wants; why should we increase them?"

"Heaven provides for the wants of men according to the places in which they live."

"I prefer to procure a new species of fruit or of grain for my subjects than to build a hundred porcelain towers."¹

"Every one desires health and loves life, but no one practises temperance and frugality. They invent pleasant remedies which they imagine will cause them to digest. Eat little, and you will digest much."

"I attribute my good health to the fact that I drink nothing but water, which I distil myself."²

ON THE EVOLUTION OF ANTLERS IN THE RUMINANTS

THE development of antlers in the Ruminants to which Sir John Lubbock alluded in his address to the British Association at York, confirms the truth of the doctrine of evolution in so clear a way that it is well

¹ For a description of the celebrated porcelain tower of Nanking, see Williams's "Middle Kingdom," vol. i. p. 82. It should be added that this remarkable work was destroyed during the occupation of the city by the Taipings, and it may be said of it now, *etiam perierunt ruine*.

² The absence of any system of drainage in Chinese cities should be remembered here.

worthy of being laid before the readers of NATURE, although I have already brought it in part before the Geological Society in 1877 (*Quart. Journ. Geol. Soc.* xxxiv. 419), and published it in outline three years later, in my work on "Early Man in Britain, and His Place in the Tertiary Period." The results of an inquiry to which I was led by a systematic study, extending over several years, of the more important collections of fossil mammalia in Britain, France, and Italy, may be summed up as follows:—

In the Middle Stage of the Miocene the cervine antler consists merely of a simple forked crown (*Cervus dicroceros*), which increases in size in the Upper Miocene, although it still remains small and erect, like that of the roe. In *Cervus Matheroni* it measures 11.4 inches, and throws off not more than four tynes, all small (Fig. 1).

The deer living in Auvergne in the succeeding or Pleiocene age present us with another stage in the history of antler development. There for the first time we see antlers of the axis and *Rusa* type larger and longer and more branching than any antlers were before, and possessing three or more well-developed tynes (Figs. 2, 3, 4, 5).

Deer of this type abounded in Pleiocene Europe, and I have examined their remains from the Red Crag of Norwich and of Suffolk, from various localities in Middle and Southern France, from Italy, and even from the little Island of Capri. They belong to the Oriental division of the Cervidæ, and their presence in Europe confirms the evidence of the flora brought forward by the Count de Saporta, that the Pleiocene climate of Middle Europe was warm. They have probably disappeared from Europe in consequence of the lowering of the temperature in the Pleistocene Age, while their descendants have found a congenial home in the warmer regions of Eastern Asia.

In the latest stage of the Pleiocene—the Upper Pleiocene of the Val d'Arno—the *Cervus dicranios* of Nesti (Fig. 6) presents us with antlers much smaller than those of the Irish elk, but so complicated as almost to defy description. This animal survived into the succeeding age, and is found in the pre-glacial forest bed of Norfolk, being described by Dr. Falconer under the name of Sedgwick's Deer (*C. Sedgwickii*).

The Irish elk, moose, stag, reindeer, and fallow deer appear in Europe in the Pleistocene age, all with highly complicated antlers in the adult, and the first possessing the largest antlers as yet known. Of these the Irish elk disappeared in the Prehistoric age after having lived in countless herds in Ireland, while the rest have lived on into our own times in Euro-Asia, and, with the exception of the last, also in North America.

From this survey it is obvious that the cervine antlers have increased in size and complexity from the Mid-Miocene to the Pleistocene age, and that their successive changes are analogous to those which are observed in the development of antlers in the living deer, which begin with a simple point and increase in number of tynes till their limit of growth be reached. In other words, the development of antlers indicated at successive and widely separated pages of the geological record is the same as that observed in the history of a single living species. It is also obvious that the progressive diminution of size and complexity in the antlers from the present time back into the early Tertiary age shows that we are approaching the zero of antler-development in the Mid-Miocene age. I have been unable to meet with a trace of any antler-bearing ruminant in the Lower Miocenes either of Europe or of the United States.

Nor are we left without direct evidence on this point. The discoveries in the Mid-Miocene shale of Sansan in the South of France, published by Prof. Ed. Lartet in 1839 and 1851, and those made in New Mexico, Colorado, and Nebraska, and published by Prof. Cope in 1874–1877, present us with a series of antlers in which the burr is conspicuous by its absence. Still more